RESEARCH HIGHLIGHTS

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MONITORING THE PERFORMANCE OF A RETROFITTED PRESERVED WOOD FOUNDATION

Introduction

Homeowners of a house in the Ottawa area experienced sensitivity to molds growing inside the wall cavities of their preserved wood foundation (PWF). CMHC became involved when the homeowners sought to resolve the moisture problems underlying that microbiological growth. This led to retrofitting the split level foundation and monitoring the effectiveness of the recommended solution.

Problem Description

Based on the site inspection and description of these symptoms, investigators felt that the main moisture source to the PWF was due to moisture movement through the bottom plate and into the lower wall area. Redistribution of moisture by convection and deposition had led to mold growth on the inner face of the polyethylene and insulation. The homeowners had already removed all insulation and vapour barrier materials. Decontamination of the PWF was accomplished by washing with a borate solution. The walls were also shrouded with polyethylene sheeting to isolate them from the rest of the basement. The space between the shrouds and the walls was depressurised using two exhaust fans venting those spaces to the outside. The moisture content of the foundation materials was low when retrofitting was undertaken.

Proposed Solutions

Several alternatives were considered. Excavation of the exterior of the foundation and installation of a drainage mat or exterior insulation was rejected as being too expensive and because of disruption to entrance stairways, wooden decks and the adjoined garage. Retrofitting the PWF from the inside was seen to be the least disruptive and least expensive. Refinishing of the interior was required anyway, and it made sense that the recommended solution involve that work. Since the greatest likelihood of re-wetting was the base of the foundation, it was recommended that the base of the wall be continuously vented to the outside. Above this vented portion, it was recommended that the wall be insulated with cellulose-fill insulation to minimize convection in the wall cavities. The vented portion of the PWF base was left uninsulated, and a 300-mm (12 in.) high ventilation cavity was formed by building a plywood baseboard set out from edge of the wall studs by approximately 50 mm (2 in.). Those cavities were depressurized using the existing exhaust fans, one for each foundation level, with partial control on the entry of indoor air into the ventilation cavity to achieve drying.

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Monitoring Plan

Two interior wall finishes were tried—unpainted drywall (with no polyethylene) and polyethylene with no drywall. Ten monitoring stations were established around the perimeter of the foundation to monitor relative humidity, moisture content in the lumber studs and wall plate, the moisture content in the plywood in the upper portion of the wall, and temperatures at various positions in the wall.

Moisture content of the wood in the base plate, wall studs and plywood was monitored by measuring the resistance between 3/8-inch uninsulated screws at each location. Precision shunt resistors were used to lower the measured resistance to a level that could be recorded by a conventional data logger. The relative humidity was monitored in the cavity at each station, as well as the temperature at each location where correction of results would be required. This permitted the wood resistance to be calculated and the moisture content to be deduced from resistance/moisture content relationships for different species of wood. Eighty (80) sensors were eventually monitored, initially at one-hour intervals, which was then reduced to two-hour intervals to reduce the frequency needed for site visits to download the information.

Mapping of the differential pressures in the wall cavities was undertaken to assess the source of make-up air. Airflow measurements in the ventilated cavity and the exhaust stream were also made to supplement the above measurements and observations.

Monitoring was done over a winter/spring and summer period beginning in December 2000 and ending in September 2001. Power failures led to some periods of missing data, but these did not affect the results or conclusions.

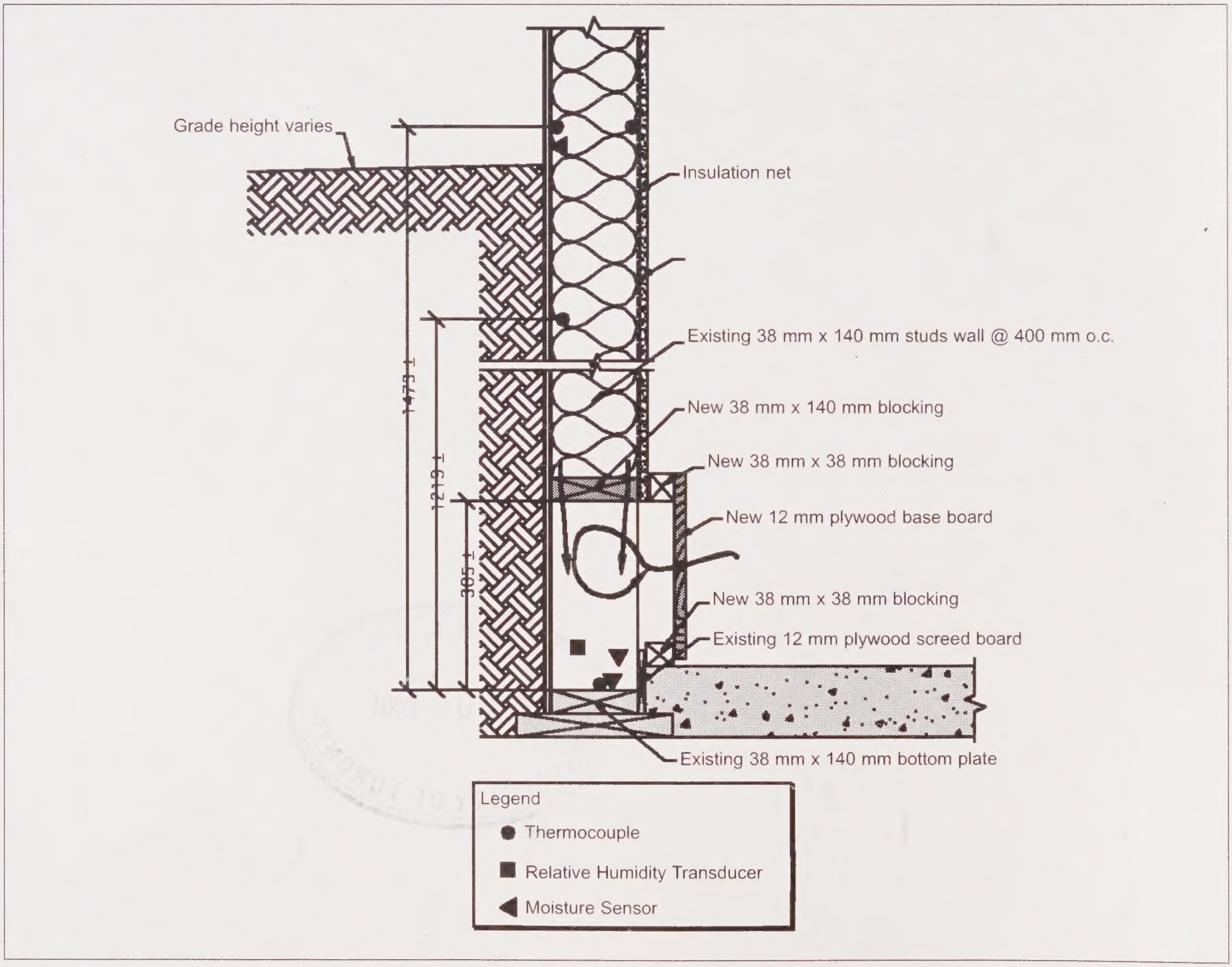

Figure 1. Typical cross-section of PWF wall

Results

Figure 1 shows a typical cross-section of the wall and ventilation cavity, and the location of sensors. The primary findings drawn from this monitoring project were:

1. The venting system seemed successful in isolating the indoor environment from the environment in the wall cavities and the ventilation cavity. Relative humidity records tracked the measured moisture contents of wood in the ventilation cavities.
2. The approach taken to ventilate the lower part of the PWF prevented the build up of excess levels of moisture that would encourage mold growth.
3. The use of blown-in cellulose insulation was assumed to have reduced convective airflow in the basement wall insulation. However the continuous operation of the ventilation system dominated that flow by drawing part of the makeup air through the insulation from the upper reaches of the walls.
4. The initial exhaust rate of about 50 L/s from each exhaust fan in December 2000 led to deposition of condensate on the above-grade portion of the plywood at one monitoring station. In January, the flow rate was throttled by a half to reduce the energy lost in the exhaust stream. The moisture eventually dissipated in the spring. In a portion of the foundation that was shielded from direct exposure to the sun by a large wooden deck, one location continued to build up in moisture and took longer to dry due to greater frost penetration and less solar drying in the summer.
5. Where polyethylene sheeting was used (10 mil in this project), little condensation was observed on the back of the plywood during the winter period.
6. The use of an unpainted drywall inner liner without a vapour barrier resulted in more accumulation of moisture in the above-grade plywood during the winter. The rate of drying appeared to be slower there than where polyethylene sheathing had been used.
7. Wetting of the foundation caused by rain in the summer appeared to occur at several monitoring locations. It was noted that the outer plywood skirt on the foundation was poorly implemented and the caulking used to seal the top of the skirt was deteriorating. A properly flashed protective skirt would minimize such incursions of moisture.
8. Where moisture did enter the upper reaches of the wall in the spring and/or summer, there was eventual dissipation.
9. Based on the relative humidity and moisture content records, it appears that increases in moisture at the base of the foundation occurred at all locations in the summer. The bedrock was very close to surface at this building site. However, the maximum moisture content in the base plate was low (under 26 per cent) except for one incursion at one corner of the house which dissipated quickly. The moisture content at the bottom of the studs in the wall, at all locations, was lower. Limited calibration of the moisture sensors was attempted by extraction of wood cores for oven drying. This data suggested that the actual moisture contents were even lower than those noted above. It was concluded that the system was successful in limiting the gain of moisture at the base of the wall and that it would facilitate drying in the event of flooding.
10. Based on the pressure gradients found in the wall cavities, it is likely that had glass fibre or mineral wool insulation been used, more uniform negative pressure would have been measured in each wall cavity. Consequently a greater quantity of air would have been drawn in from the upper reaches of the walls. One would have to pay special attention to air sealing at the upper portions of the wall to limit this flow.
11. There did not seem to be any ill effects to the occupants' health, either caused by odours or other reactions, so it was assumed that this system of depressurisation adequately controlled air leakage and prevented entry of air from the wall cavities into the living space. Some of the inferred moisture contents are high enough to cause surface molds to grow on untreated wood.

Conclusion

For PWF where the moisture source lies at the base of the wall, the ventilation system employed in this study is likely the least expensive retrofit that can be employed to keep the base dry most of the time. If, however, large inflows of moisture occur, it will be necessary to deal with the problem on the outside of the foundation by improving drainage and removal from the footprint of the house.

A protected 25-mm (1 in.) thick layer of insulating foam board on the outside for the above grade portion of the PWF should also be considered. This would significantly minimize condensation potential on the inside of the PWF wall.

A ventilation system that would only respond to higher RH levels would be desirable to reduce energy costs. This would be difficult to implement because localized wetting may not be detected easily. A two-speed exhaust fan, with a continuous low-speed operation, might overcome this restriction.

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